

UNPUBLISHED PRELIMINARY DATA

V. Kansas

RADAR SENSING FOR
GEOSCIENCE PURPOSES

Monthly Progress Report, MR 61-4
NASA Contract #NSR 17-004-003
1 November 1964 to 1 December 1964

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I. INTRODUCTION - This report details activity for the month of November 1964 on the program "Radar Sensing for Geoscience Purposes," Contract #NSR 17-004-003.

II. GENERAL COORDINATION - Contract negotiations with Acadia University have not as yet been finalized, however H. Cameron has been active in the program. The Kansas State University sub-contract is still pending. H.S. Hayre is conducting investigations in cooperation with the University of Kansas, although equipment purchases have been delayed until the final contract is issued.

Considerable effort is being devoted to compiling the Radar Team Reply for the NASA Questionnaire regarding the AES earth-orbital spacecraft. The experiment being proposed is titled "Uses of Radar in Manned, Earth-Orbital Spacecraft for Geoscience Purposes." The experiment will use radar as a remote sensor for the observation of natural and cultural phenomena of the earth. A preliminary copy of the proposal has been prepared on the basis of contributions from the circulated members of the Radar Team. This draft will be used as a guideline for discussion at the Coordination Meeting.

A Coordination Meeting has been scheduled for December 15 and 16, 1964 at the University of Kansas, Lawrence, Kansas. Preparations for this meeting are underway and all team members and interested observers have been invited.

III. TASK A - DECLASSIFICATION

No major declassification of imagery or documents occurred in November, however Mr. Schops has made a small number of prints of recently

declassified imagery available for an initial technical report.

IV. TASK B - GEOSCIENCE

During November the Geoscience effort hinged around the following:

At the University of Kansas three sites were documented in Virginia for late November flights by the NRL aircraft if possible -- at Manassas, Orange and James River areas, Virginia. The three sites straddle basic sills and mixed basic and acid intrusives.

In preparation for later flights by the NRL aircraft, and possibly by the WADC aircraft, additional geologic sites were documented in the Uinta Basin of Utah, and Canon City and Pike's Peak areas of Colorado, and the Rose Dome area of Kansas.

The first data from the NRL flights in August were received in November at the University of Kansas and the flight lines were plotted on vertical air photographs. Work also continued on organizing the data from the WADC flights over Garden City and Douglas County, Kansas. Preliminary analysis of the St. Francis Mountains (Missouri) data obtained by the WADC tri-sensor aircraft, was carried out under the direction of L. Dellwig.

In preparation for the December Coordination Meeting, the matter of suitable lunar-analog material for WES analysis was gone into thoroughly and extensive telephone calls were made to, interalia, Gawarecki, USGS, and the Astro-Geology group, Flagstaff, Arizona. Also, for coordination purposes, geologic and soils data for Ohio were assembled for ease in discussing local sites for W. Peake and associates at the December Coordination Meeting.

D. S. Simonett also visited Project Michigan and Conductron Corporation to inspect high resolution imagery and order copies for project use.

B. B. Scheps initiated steps for the possible acquisition of AN/APQ85 brute-force radar system for installation on NASA aircraft, and made several visits to Goodyear aircraft, completing suitable reports of each. GIMRADA's November progress report is Appendix A.

All team members responded to the lunar and earth applications questionnaire for the radar team response.

V. TASK C - RADAR AND LABORATORY MEASUREMENTS

Ohio State University has made a study of the feasibility of truck-based radar measurements at L-band (1000 mc). It was concluded that L-band measurements were not practical since calculations show the largest tolerable spot size on the ground to be only two wavelengths in diameter. Therefore, it was decided to center the low frequency radar at 1800 mc. This unit will complement the three radars now available at K_a , K_u , and X bands. The Ohio State University status letter for November is Appendix B.

The University of Kansas has received two radar sets and is preparing for their installation. These radars, APS-15 and SO-8, will be mounted to illuminate a specific terrain area. Daily recording of radar return and synoptic facts pertaining to the illuminated areas will be made over a period of several months.

The Waterways Experiment Station has conducted radar tests to determine the effects of soil moisture content on the radar reflections from simulated terrain. The first sample tested consisted of Sharkey clay obtained from Sharkey County, Mississippi. Tests on one sample with a moisture content of approximately 10% were completed and tests on a second with a moisture content of approximately 25% were begun. A special vegetation sample of winter wheat planted in Richfield silt loam with a moisture content of approximately 30% was constructed in order to determine the effect of vegetation on reflected radar waves. Radar signatures were run at a vegetation height of 3 1/2" and will be rerun at intervals throughout the growth cycle of the wheat. The Waterways Experiment Station's November status report is Appendix C.

VI. TASK D AND E - RADAR FLIGHT TESTS AND NEW TECHNIQUES

During November, the WADC aircraft recorded data over a pre-selected site in the St. Francis Mountains of Missouri. Both side-looking radar

imagery and infra-red imagery was obtained. The radar imagery was obtained at an altitude of 2000 ft. and the infra-red imagery was obtained at an altitude of 7000 ft. This was done at the specific request of The University of Kansas personnel, however it was decided after viewing the imagery that it would be more suitable to record the radar imagery in future at 7000 ft. This procedure will be followed when the aircraft is again available to the program. This is estimated to be in early spring. Radar and infra-red imagery was also obtained over Pisgah Crater, and a second flight was made on November 23 over the Garden City site in western Kansas. Data from these latter sites have not yet been duplicated and forwarded to the University of Kansas, though the St. Francis Mountains data has been in the hands of L. Dellwig since late November.

On November 25 the NRL aircraft flew for the program and attempted to obtain data over preselected sites in Virginia, at Manassas and Orange. John Rouse, KU, was an observer on this flight. The weather conditions limited visibility to the extent that the desired sites could not be located and therefore no data was obtained. Macdonald has rescheduled the flight during the first two weeks in December.

Nearly all of NRL's data from the September flights over Mono Lake, California and Pisgah Crater, California has been transferred to the University of Kansas. This includes 70 mm photographs of the terrain looking vertically, 35 mm photographs of the PPI imagery, and medians of each 32 signal amplitudes on punched-paper tape. The drift sight films are not yet available. The antenna-pattern measurements taken over Utah were found to have saturated the receiver. The pattern measurements will be repeated at a later date.

The multi-color display circuitry is being fabricated and is expected to be ready for a demonstration of the presentation idea at the December Coordination Meeting. The completion of the display is scheduled for late February 1965.

Kansas State University has begun a coincident, but independent, study of the penetration problem previously initiated by KU. The Kansas

State University November progress report is Appendix D.

VII. TASK F - SPACECRAFT EXPERIMENT PLANNING

A spacecraft experiment program is being prepared as a proposal for the A.E.S. earth-orbital spacecraft. The experiment is designed as a series of progressively sophisticated radar systems. The ultimate instrument is a multi-frequency, multi-polarization radar with a resolution of about 10 meters. It also includes an interferometer-type profiler and an accurate altimeter. Such a system is capable of measuring: 1) size, shape and interrelations of features on the earth's surface. 2) roughness parameters and dielectric properties of the earth's surface. 3) polarization effect due to properties of the earth's surface. 4) altitude with extreme accuracy. The composite radar team proposal will be discussed and reviewed during the Coordination Meeting in December, and a modified team proposal will be prepared.

VIII. CONCLUSION - To ensure complete clarity, the monthly reports of the reporting organizations will be appended to the composite monthly progress reports. The progress reports must be received at the University of Kansas within one week following the end of each monthly report period so that the contributions of the associated organizations may be recognized in the progress report.

APPENDIX A

GIMRADA

Progress Report on Geoscience Data Extraction from Radar Imagery
November 1964

The tri-sensor aircraft flew six flights in support of the overall radar team effort with varying amounts of success. Some difficulty was experienced with imagery obtained at altitudes below optimum designed altitude. Familiarization is improving the quality of results.

Air Force has not yet responded to the MIPR. Despite this, they are cooperating in the flight program in an excellent manner. The Project Engineer called the GIMRADA Field Office at WADC to see if a response could not be expedited so that they could be paid for their efforts.

A number of prints were made of recently declassified imagery in preparation for an initial technical report.

Responses were prepared for both lunar and earth applications for inclusion in the radar team response to NASA questionnaires.

Stereo radar recently acquired was viewed. It is excellent. Additional copies were requested for use in this program.

A lengthy telephone conference was held with Messrs. Moore and Simonett (KU) and the Project Engineer on the subject of a long term systematic development concept for all radar orbiters (lunar and earth).

Contacts were made which show promise of making an AN/APQ85 radar available for our exclusive use.

In December, a contractual arrangement for interpretation support will be concluded.

A technical report will be initiated.

The Project Engineer will attend a team meeting at Kansas University.

Bernard B. Scheps
Project Engineer

APPENDIX B

Ohio State University, Antenna Laboratory
Monthly Status Letter, Contract NSR-36-008-027
November, 1964

During the past month, our principal effort has been expanded in equipment preparation.

A study was made of the feasibility of truck based measurements at L band (1000 mc). It was concluded that because of the limited distance between antenna and ground, (20 feet) and the desire to limit the illuminated area (required to limit the range of angles contributing to the radar return to less than about 10°) it was not feasible to maintain reasonable phase characteristics over the illuminated area. The basic difficulty is that the largest tolerable spot size on the ground is only two wavelengths in diameter. Thus it has been decided to operate the fourth "ground-truth" radar at 1800 mc. A parabola with variable feed distance has been constructed and is now under test to obtain, by empirical methods, a defocussed feed design which will provide the best compromise between spot-size and uniform phase in the working region.

Work on the radiometer check-out is continuing. The synchronous detector has been tested and found to have adequate linearity and dynamic range. Matched loads which may be inserted directly in the antenna feeds are under construction. These, it is hoped, will permit rapid field calibration of the radiometers.

No significant progress is reported on other aspects of the program. Only one questionnaire was received during the month.

William H. Peake
Associate Supervisor

APPENDIX C

U.S. Army Waterways Experiment Station
Monthly Status Report
November, 1964

Progress during period 1-30 Nov 1964

1. Radar tests to determine the effects of soil moisture content on the radar reflections from simulated terrain were started with Sharkey clay obtained from Sharkey County, Miss. Tests on one sample with a moisture content of approximately 10% were completed, and tests on a second sample with a moisture content of approximately 25% were begun.

2. A special vegetation sample of winter wheat planted in Richfield silt loam with a moisture content of approximately 30% was constructed in order to determine the effects of vegetation on reflected radar waves. Radar signatures were run at a vegetation height of 3-1/2 in. and will be rerun at intervals throughout the growth cycle of the wheat.

Work contemplated 1-31 Dec 1964

3. Radar tests will be continued with laboratory testing of samples of Sharkey clay and samples of Richfield silt loam from Finney County, Kans. Signatures of the wheat planted in Richfield silt loam will be run using Ka-, X-, C-, and P-band radar. Results of these tests will be tabulated and forwarded to the NASA data center after completion of the series of studies on each soil type.

J.B. Tiffany
Engineer
Technical Director

APPENDIX D

Kansas State University
Monthly Progress Report, Contract CRES 61-1
November, 1964

Radar Imagery

(a) Full-scale Experiment

(i) Data

The usefulness of Macdonald's P.P.I. scope data was discussed with CRES personnel and the possibility of sidelooking radar data was also explored. CRES has now received the filmed data from NRL but as yet has not mailed it to us. It is expected that this data will reach us during the month of December.

(ii) Extraction of Information from Radar Data

In accordance with our work schedule a special fram has been designed and constructed and the KSU densitometer is ready to be used for reading 35-mm film.

Fiber optic tubes and sensor prices have been obtained. The tubes are not too expensive, whereas the sensors are. As soon as a final agreement is reached between Dr. R. K. Moore and his group regarding semiautomatic reading of such filmed data, orders for necessary equipment will be placed. Subcontractual limitation on expenditure on equipment by CRES has not as yet been lifted pending the final signing of the subcontract.

(b) Acoustic Simulation

(i) Experimental and Theoretical

No equipment can be ordered until subcontractual limitation on such spending is lifted, and therefore any further progress is stalled.

Target is ready except for simulating of a randomly rough surface. This is awaiting our final decision on frequency separation study under way.

(c) Return Pulse Shape

A study has been initiated to determine the shape of an electromagnetic pulse reflected by a two-layered media, assuming the transmission coefficient of the top layer is essentially unity.

(d) Travel

Professor Hayre visited the University of Kansas for technical discussions.

(e) Publications

None.

H. S. Hayre
Kansas State University

APPENDIX E

Outgoing Long Distance Calls Originated for Project #61 CRES, The University of Kansas July 1, 1964 to December 1, 1964

July

Badgley	NASA	3
Barath	Jet Propulsion Lab	1
Brown	Jet Propulsion Lab	1
Fischer	USGS	2
Herald	Watershed Experiment Station	1
Holter	Willow Run Res. Lab	1
Jamison	University of Missouri	1
Macdonald	Naval Research Lab	2
Peake	Ohio State University	2
Pierce	Ohio State University	2
Scheps	GIMRADA	3
Shay	Purdue University	2

August

Backus	Oceanographic Institute	1
Badgley	NASA	2
Barath	Jet Propulsion Lab	1
Brown	Jet Propulsion Lab	1
Cameron	Acadia University	1
Cronin	AFCRL	1
Davis	Waterways Experiment Station	2
Jamison	University of Missouri	2
Kothe	GIMRADA	1
Macdonald	Naval Research Lab	3
Nelson	W. Kansas Site (Exp. Sta.)	1

August (cont'd.)

Nossaman	W. Kansas Site (Exp. Sta.)	3
Peake	Ohio State University	1
Pierce	Ohio State University	2
Rossby	Oceanographic Institute	1
Scheps	GIMRADA	3
Vickers	NASA	1
Planetology Sub-Committee	Chicago	1

September

Badgley	NASA	2
Brown	Jet Propulsion Lab	1
Childs	NASA	2
Guinard	Naval Research Lab	2
Macdonald	Naval Research Lab	1
Simpson	NASA	1
Whiting	Bureau of Weapons	3

October

Badgley	NASA	1
Beck	Fifth Army	1
Behnan	Wright-Patterson	1
Brown, W.E.	Jet Propulsion Lab	2
Brown, W.N.	Willow Run Research	1
Daniels	Wright-Patterson	1
Evans	Lincoln Lab	1
Gawarecki	Geological Survey	1
Guinard	Naval Research Lab	1
Peake	Ohio State University	1
Pettengill	Cornell University (Puerto Rico)	1
Porcello	University of Michigan	1
Scheps	GIMRADA	1
Wilner	NASA	1

November

Alexander	Office of Naval Research	2
Badgley	NASA	3
Boar	NASA	2
Brown, W.E.	Jet Propulsion Lab	1
Brown, W.N.	Willow Run Research Lab	1
Cameron	Acadia University	1
Davis	Waterways Experiment Station	2
Delisle	MIT	1
Demetter	GIMRADA	1
Fischer	USGS	2
Graham	Conductron	1
Grimes	Richards Corporation	1
Guinard	Naval Research Lab	1
Illemsky	GIMRADA	1
Katz	Johns Hopkins University	1
Macdonald	Naval Research Lab	1
Martin	Midwest Research Institute	1
Nossaman	Kansas State Agricultural Exp. Sta.	1
Peake	Ohio State University	1
Schulenberg	U.S. Army Electronics Lab	1
Scheps	GIMRADA	3

APPENDIX F

DISTRIBUTION LIST

26	NASA Grants Office	
1	Badgley, P.	NASA
1	Barath, F.	JPL
1	Barringer, A.	Barringer Research Ltd.
1	Brown, W. E.	JPL
2	Brown, W. M.	Univ of Mich
1	Cameron, H.	Acadia Univ
1	Childs, L.	NASA, Manned Space Center
1	Davis, B.	WES
1	Fischer, W.	USGS
1	Fordyce, S.	NASA
1	Gaugler, E.	NASA
1	Gawarecki, S.	USGS
1	Gilles, J.	GIMRADA
1	Griswold, N.	WADC
1	Hayre, H.	Kansas State Univ
1	Jones, D.	JPL
1	Katz, I.	Applied Physics Lab, Johns Hopkins
1	Kothe, K.	GIMRADA
1	Leestma, J.	GIMRADA
1	MacDonald, F.	NRL
1	Molineux, C.	Air Force CRL
1	Peake, W.	Ohio State Univ
1	Pierson, W.	NYU
1	Pincus, H.	Ohio State Univ
1	Robin, G. de Q.	Scott Polar Res. Inst.
1	Schultz, C.	Ohio State Univ
1	Shepard, J.	GIMRADA
1	Simons, J.	Autometric Corp.
1	Speed, R.	JPL
1	Scheps, B.	GIMRADA
1	Whitten, T.	Northwestern Univ